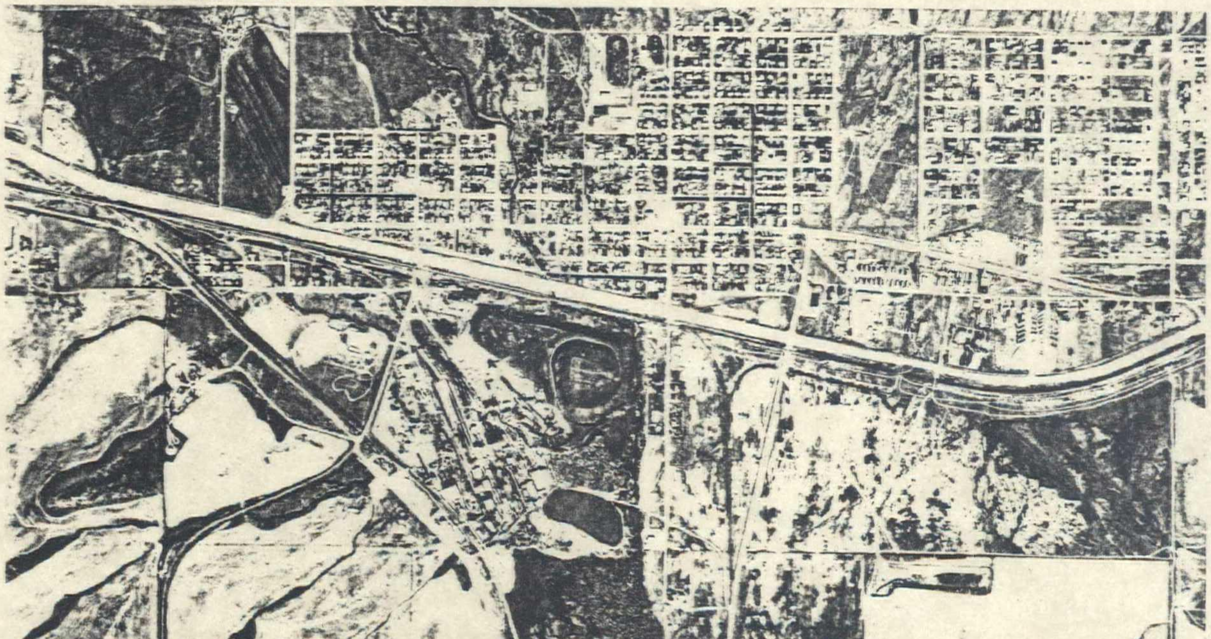
Process Ponds Remedial Investigation / Feasibility Study Work Plan

Prepared For:

ASARCO INCORPORATED
East Helena Plant



Prepared By:

Hydrometrics
Consulting Scientists and Engineers
Helena, Montana

0130443

ASARCO

EAST HELENA PLANT

M. A. SHARP

JUNE 12, 1987

MR. SCOTT BROWN
REMEDIAL PROJECT MANAGER
U.S. ENVIRONMENTAL PROTECTION AGENCY
FEDERAL BUILDING - DRAWER 10096
301 SO. PARK
HELENA, MT 59626

DEAR SCOTT:

ATTACHED ARE THREE COPIES OF THE REVISED DRAFT PROCESS PONDS REMEDIAL INVESTIGATION/FEASIBILITY WORKPLAN WHICH ADDRESSES THE WATER RESOURCE STUDY REQUIREMENTS NEEDED TO EXPEDITE SUBSEQUENT REMEDIAL ACTIONS FOR THE PROCESS PONDS. THIS REVISED DOCUMENT INCORPORATES RESPONSES TO YOUR COMMENTS OUTLINED IN YOUR LETTER OF MAY 15TH AS PREVIOUSLY DISCUSSED IN OUR JOINT MEETING OF JUNE 5TH.

ASARCO CONTINUES TO HAVE AN INTEREST IN FULLY UNDERSTANDING THE "NON-TIME CRITICAL REMOVAL PROCEDURE" AND HOW IT MIGHT BE APPLIED TO OUR WORK DEALING WITH THE PROCESS POND RI/FS PROCESS.

I'LL LOOK FORWARD TO HEARING FROM YOU EARLY NEXT WEEK REGARDING THESE MATTERS.

SINCERELY,

Jon C. Nickel

JON C. NICKEL
INDUSTRIAL QUALITY MANAGER

JCN/CAR
CC: M.RUBICH, SHWB W/ENCL.

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C130444

PROCESS PONDS REMEDIAL INVESTIGATION/ FEASIBILITY STUDY WORK PLAN

for

Jon Nickel
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by

HYDROMETRICS
2727 Airport Road
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406/443-4150

June 1987

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Dave: Field Operation Plans? 0130447

overall comment: Good

ASARCO EAST HELENA PROCESS PONDS REMEDIAL INVESTIGATION/ FEASIBILITY STUDY WORK PLAN

Comment: p 3 item 2

INTRODUCTION

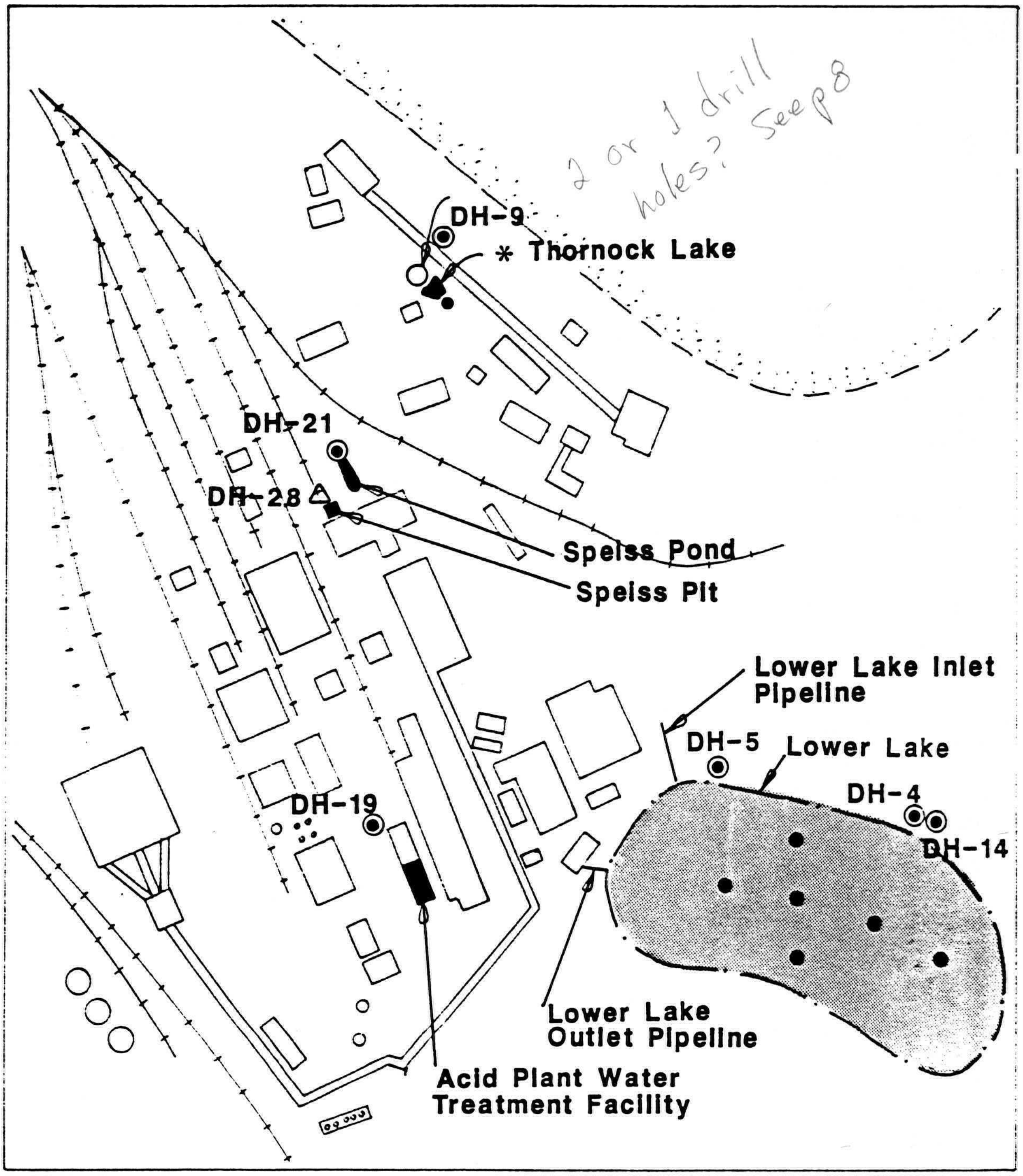
This Remedial Investigation/Feasibility Study (RI/FS) work plan addresses the water resources study requirements to expedite subsequent remedial actions for process ponds at the East Helena ASARCO smelter site. The process ponds addressed in this work plan include: Thornock Lake, Lower Lake, the speiss pond and pit, and the acid water treatment facility (see Figure 1). The Phase I ASARCO Water Resources Monitoring (WRM) Investigation (Hydrometrics, 1986) has identified Lower Lake and Thornock Lake as probable contributors to groundwater degradation in the ASARCO smelter area. Plant site examination conducted as part of the ongoing Phase II WRM investigation has identified the speiss pond and pit and the acid water treatment facility as probable contributors to groundwater degradation. Additional Phase II monitoring well drilling, groundwater sampling and soil sampling is being conducted to evaluate the contribution to groundwater degradation by these two process pond facilities.

The objectives of this work plan are:

1) Protect human health and the environment

2) Provide any additional remedial investigation data necessary for the process pond endangerment assessment and the remedial action feasibility study.

3) Evaluate a range of remedial action alternatives that would protect groundwater from further degradation by the process ponds.



◉ Existing Monitoring Well
△ Proposed Monitoring Well
● Proposed Soil Core Drill Hole
Process Pond

*Process Fluids Removed To A Steel Holding Tank

Figure 1

Process Pond Location Map

Potential general response actions for the process ponds include:

1) No action.

2) Sealing ponds to prevent leakage.

3) Removal of ponds and associated sediments. Ponds would be replaced by:

   a) Lined ponds or basins

   b) Above ground tanks

? doit?

The process pond RI/FS study will utilize information from the following documents:

1) Quality Assurance Program Plan ASARCO East Helena Plant Water Resources Investigation by Hydrometrics, September 21, 1984.

2) Hydrological Investigation of the ASARCO East Helena Water Resources Monitoring Plan by Hydrometrics, June 29, 1984.

3) Report on Water Resources Monitoring ASARCO East Helena Plant - Draft by Hydrometrics, February 7, 1986.

4) Water Resources Investigation ASARCO East Helena Plant Phase II Remedial Investigation Work Plan - by Hydrometrics, August 19, 1986.

The Quality Assurance Program Plan and the Phase II Remedial Investigation Work Plan are the basic quality assurance documents for this process pond RI/FS study. Where new field or laboratory technical methods are used in the process pond RI/FS study, supplemental quality procedure(s) have been prepared and are included in this work plan in Appendix 1.

The WRM draft report and data collected as part of the ongoing Phase II investigation will provide the basic hydrogeological background for the process pond RI/FS work. Additional background data also has been collected as part of the existing plant water balance investigation conducted in cooperation with the Montana Department of Health and Environmental Sciences (DHES), Water Quality Bureau.

This process pond RI/FS work plan will be separated into seven major study elements:

1) Characterization of Process Fluids,
2) Investigation of Pond Bottom Sediments and Underlying Soils,
3) Plant Water Balance Investigation,
4) Quality Assurance and Quality Control,
5) Endangerment Assessment,
6) Remedial Action Alternatives Feasibility Study
7) Reports and Data Management.

Each of these study elements is described in this work plan and the methodology for completion of each element is explained.

CHARACTERIZATION OF PROCESS FLUIDS

EXISTING DATA

Process fluid chemistry data of Lower Lake and Thornock Lake is included in the Phase I Draft WRM Report (Hydrometrics, 1986). Additional samples have been collected from Lower Lake as part of the Phase II WRM investigation. Fluid samples have also been collected from the acid plant water treatment facility and the speiss pond. Pond fluid samples were analyzed per the special analytical schedule described in the Phase II work plan.

ADDITIONAL DATA REQUIREMENTS

Process ponds were sampled in spring 1987 as part of the ongoing Phase II WRM investigation. Additional samples will be collected from Lower Lake, the acid plant water treatment facility, and the speiss pond and granulating pit to determine temporal variations of process pond fluid quality.

The process pond sampling program will consist of:

1. An evaluation of pond fluid management practices to determine cyclic times and events which may cause temporal variations of pond fluid chemistry.

2. Four pond sampling campaigns designed to define temporal pond fluid chemistry variations. The sampling campaigns will be based on identified pond fluid management cycles and will consist of collecting pond fluid samples at various times within a cycle. Individual sampling programs will be developed for each process pond based on identified pond management cycles. Each process pond will be sampled as follows:

   a) Inflow(s) into the process pond

   b) Outflow(s) from the process pond.

An additional sample will be collected from the main body of Lower Lake. As in previous WRM investigation activities, the samples from will be depth integrated and therefore will be representative of average pond fluid chemistry at the time of sample collection.

Fluid samples collected from process ponds will be analyzed for parameters shown in the analytical schedule on Table 1. Parameters listed on Table 1 include those tested in the Phase II WRM investigation.

The analytical schedule also includes sediment analyses necessary to provide information for evaluation of pond remedial action alternatives and includes suspended solids (TSS), grain-size distribution and settleable matter. These sediment data will be required if alternate containment facilities are constructed. Grain size distribution and settleable matter will determine volume and type of sediment expected which will affect design of sediment basins or other sediment handling equipment. Additional sediment samples may be collected in response to runoff or other plant conditions to assure an understanding of sediment loads. Field and laboratory techniques for determination of TSS and grain-size distribution are described in the Phase II WRM QAPP. The procedure to determine settleable matter is in the QAPP Addendum in Appendix 1.

Process fluids, formerly stored in Thornock Lake, are now contained in a steel holding tank facility. This storage tank facility has eliminated the potential of process fluid leakage at the Thornock Lake site and further characterization of process fluids at this location is not necessary. Additional testing will be conducted, however, on sediment in the pond bottom.

TABLE 1. PARAMETERS TO BE TESTED IN PROCESS POND FLUID SAMPLES

Specific Electrical Conductivity (field and lab)	Calcium (Ca)
Total Dissolved Solids (TDS)	Magnesium (Mg)
Static Water Level	Sodium (Na)
pH (field and lab)	Potassium (K)
Temperature	Bicarbonate (HCO_3)
Total Suspended Solids (TSS)	Carbonate (CO_3)
Grain-Size Distribution	Sulfate (SO_4)
Settleable Matter	Chloride (Cl)

Arsenic (As)	Copper (Cu)	Lead (Pb)	Zinc (Zn)
Cadmium (Cd)	Iron (Fe)	Manganese (Mn)	

others?

NOTE: Metals will be measured both as Total and Dissolved

Dave: Did you?

Has Jon considered characterizing sediments after draining the lower pond?

C130454

See notes

INVESTIGATION OF POND BOTTOM SEDIMENTS AND UNDERLYING SOILS

The chemical characteristics of Lower Lake and Thornock Lake pond bottom sediments are included in the Phase I draft WRM report (Hydrometrics, 1986). Bottom sediments were obtained from random locations using a small boat and a manually operated BMH-53 piston-type core sampler. Since the BMH-53 sampler only obtains samples from the uppermost foot of bottom sediments, the depth of bottom sediments in Lower Lake and Thornock Lake are not known. Laboratory results indicated Lower Lake and Thornock Lake bottom sediments have elevated metals and arsenic concentrations.

other process ponds too + Speiss pit + acid treat

Additional soil cores will be collected from Lower Lake and Thornock Lake to determine the depth, areal extent, chemical content and physical characteristics of pond bottom sediments and of underlying soils. Soil cores will be collected at two foot intervals using Shelby tubes when possible, or using split spoons. Drilling at Lower Lake will be performed using a floating barge-mounted drill rig. Drilling at Thornock Lake will be performed using a forward rotary rig with top drive hammer as used during the Phase I and Phase II WRM investigation. Access to Thornock Lake will be provided by construction of pads in portions of the former pond. Soil cores will be collected from six drill holes at Lower Lake and two drill holes at Thornock Lake. The drill holes will be plugged with bentonite after sample collection is complete. Drill hole locations are in Figure 1 and are selected to provide soils data representative of pond bottom sediments and underlying soils.

**

Existing soil data collected from drill holes constructed during the Phase I WRM investigation (DH-4, DH-5 and DH-6) suggest fine grain pond bottom sediment soils in Lower Lake and Thornock Lake will be 12 to 18 feet and 5 to 8 feet deep, respectively. In Lower Lake, the fine-grained sediments are probably underlain by coarse-grained alluvial gravels. The goal of soil core drilling is to collect samples through the fine-grained sediments and, if possible, determine field operation techniques or outline

implications on AO??

extent of contamination underlying alluvial sediments. In Lower Lake, drilling and soil core sampling of coarse alluvial gravels from barge-mounted drilling equipment may not be possible. However, information on alluvial gravels immediately adjacent to Lower Lake is available from existing drill holes DH-4, DH-14 and DH-5 (see Figure 1).

Selected samples of undisturbed fine-grained materials collected using Shelby tubes will be tested in the laboratory for permeability and porosity in accordance with the QAPP. Physical parameters to be tested on selected split spoons samples will be particle size and cation exchange capacity. All soil cores will be analyzed for metals and pH. Metals to be measured are arsenic, cadmium, copper, iron, lead, manganese and zinc. Selected cores will be analyzed using the sequential extraction technique as described in the Phase II work plan. Cores representative of horizons encountered during drilling will be selected jointly by ASARCO and the Environmental Protection Agency (EPA) technical personnel.

Chemical content and physical characteristics of soils near the acid plant water treatment facility and the speiss pond and pit will be determined by soil sampling and monitoring well drilling completed as part of the WRM Phase II investigation. Soil cores have been collected at two foot intervals for the first ten feet, followed by samples at about five-foot intervals. Additional soil core samples were collected when significant lithological differences were encountered. These additional samples were collected based on field observations and are consistent with drilling and sampling practices described in the ASARCO Water Resources Monitoring Plan (WRMP) and with the Phase II work plan. The analytical parameter schedule for soil core samples described in the Phase II work plan will be used in this work plan including Lower Lake and Thornock Lake soil core analyses.

An additional monitoring well (DH-28) will be drilled downgradient of the speiss pit using the drilling procedures described above. Results of soil samples from DH-28 and from existing monitoring wells DH-21, DH-16, DH-26 and DH-23 will be used to delineate the extent of contamination around the speiss pond and pit area.

Are these wells suff. to det. contam. in Speiss pit? Areal extent there too.

ARAR's search before techniques

PLANT WATER BALANCE INVESTIGATION

Evaluation of process pond remedial action alternatives is dependent on data provided by the plant water balance investigation. The plant water balance is particularly important to the evaluation of Lower Lake remedial action alternatives. Remedial actions to be evaluated for Lower Lake must consider both the fluid storage capacity necessary to maintain routine smelter operations and additional storage capacity necessary to contain storm surface runoff.

DETERMINATION OF NET GAINS OR LOSSES OF PLANT PROCESS WATERS DURING NORMAL PLANT OPERATIONS

Determination of the plant process fluid circuit will consist of:

1. Installation of two clamp-on ultrasonic doppler flow meters at the main Lower Lake inlet (steel tank discharge) and outlet (main plant pumphouse) stations. The flow meters will be accurate to 2 percent and will be equipped with flow display computers, flow recorders and flow totalizer.

2. Long-term continuous monitoring of all Lower Lake inflows, outflows and evaporation rates will provide necessary data on net gains and losses, and peak and/or temporary input/output differences. Evaporation data will be collected using a standard Class "A" pan located at the edge of Lower Lake. The procedure for collection of evaporation data is in Appendix 1. These data will be essential for a technical evaluation of Lower Lake process pond remedial action alternatives.

DETERMINATION OF ADDITIONAL FLUID STORAGE CAPACITY NECESSARY TO CONTAIN STORM RUNOFF

A determination of storage capacity required to contain storm runoff is necessary to size containment facilities that may be proposed as a remedial action alternative. Delineation of plant drainage areas and surface runoff direction has been conducted as part of the Phase II investigation. Drainage area information along with precipitation duration and frequency information will be used to estimate the fluid storage capacity necessary to contain extreme runoff events.

Sediment erosion and subsequent deposition as a result of storm runoff and periodic plant washdown will be investigated by the analyses of process pond fluid sediment (see Characterization of Process Fluids section). Overland runoff in the plant is routed through the main plant process fluid circuit and is ultimately discharged to Lower Lake. Sediment data collected at the main Lower Lake inlet during storm runoff and/or plant washdown events will provide erosion rate/deposition data necessary to evaluate remedial action alternatives.

Is this sampling of a storm event adequate?
Dave will det.

QUALITY ASSURANCE AND QUALITY CONTROL

As part of the Phase I water resources investigation, a comprehensive Quality Assurance Program Plan (QAPP) was prepared and the plan was approved by the EPA. This plan described personnel responsibilities, organization, quality assurance activities, field operating procedures, standard laboratory procedures, the health and safety plan, decontamination of sampling equipment and sample documentation. New procedures for the Phase II portion were described and included in an addendum to the original project QAPP as part of the Phase II work plan. The QAPP and the Phase II work plan are being used for the Phase II study and also will be used for the Process Pond RI/FS investigation. Management and field personnel will be the same for the Process Pond RI/FS as for Phase II and Phase I. As previously discussed, new procedures for this RI/FS work plan have been included in an addendum to the original project QAPP (Appendix 1).

All field procedures used for the process pond RI/FS investigations are described in detail in the QAPP, the Phase II QAPP addendum and the RI/FS addendum. The ASARCO laboratory also has developed a quality assurance plan for the laboratory analytical program. The ASARCO laboratory will provide analytical support for this RI/FS work. No changes in laboratory protocol and procedures are necessary for the Process Pond RI/FS investigation.

- new F. O. Plan for sed. sampl.
- decontam. procedures need to be reevaluated

ENDANGERMENT ASSESSMENT

An endangerment assessment will be conducted to evaluate the potential risk to human health by process pond fluids. The endangerment assessment will examine exposure pathways and receptors of contaminants associated with process pond fluids. Data gathered to date as part of the ongoing site investigation activities suggests the primary exposure pathways from process ponds contaminants is through groundwater migration with surface water being a somewhat more remote exposure pathway. Information collected as part of the ongoing Phase II WRM investigation has identified groundwater and surface water uses in the East Helena area and this information will be useful in assessing the risk potential associated with process pond fluid contaminant migration.

Do they have a good feel for SARA?

REMEDIAL ACTION ALTERNATIVES FEASIBILITY STUDY

The feasibility study for the process pond remedial action alternatives will consider a range of alternatives beginning with a no-action alternative and expanding through alternatives that meet all applicable federal, state and local relevant and appropriate requirements (ARAR's). The Feasibility Studies will comply with the most recent EPA guidelines to achieve consistency with the Superfund Amendments and Reauthorization Act (SARA). Remedial action alternatives will address exposure pathways identified as part of the Process Pond RI endangerment assessment and meet or exceed remedial response objectives.

General response actions for each of the process ponds will be assembled. The goals of general response actions will include contaminant source control and management of contaminant exposure pathways. A technology review will be conducted for each general response action and a detailed list of remedial action alternatives will be developed. Each remedial action alternative described will undergo a detailed screening process using a ranking matrix. The screening criteria will include:

1. Technical feasibility
2. Environmental and public health evaluation
3. Institutional requirements
4. Costs
5. Any other relevant information

Technical Feasibility

Available technology for design, construction and operation will be screened for applicability, feasibility and reliability. Screening will include examination of the suitability for conditions at the ASARCO East Helena plant area, previous uses and reliability of the available technology.

Environmental and Public Health Evaluation

Environmental and public health impacts will be used to evaluate beneficial and/or adverse impacts of a remedial alternative. Health effects will be considered both for the general public and site workers. Remedial alternatives also will be evaluated for effectiveness in meeting clean-up criteria.

Institutional Requirements

All applicable federal, state and local relevant and appropriate requirements (ARARS) identified as part of the early process pond RI activities will be criteria used to assess each remedial action alternative.

Costs

Capital, operating and maintenance costs will be examined for remedial action alternatives. Each remedial action will be evaluated for cost effectiveness versus benefit produced. well

Based on the remedial action screening process, a summary of applicable remedial action alternatives will be presented and remedial action recommendations will be presented.

REPORTS

The following reports will be prepared:

1. Status report
2. Process Pond Remedial Investigation Report
3. Preliminary Remedial Action Alternative Assessment
4. Process Pond Feasibility Study Report

Status Report

Status reports on ongoing investigation activities are submitted to the EPA every two months. These reports follow the format described in the EPA Conceptual Work Plan (CH2M Hill, February 1986). Process Pond RI/FS activities will be included in the bimonthly interim reports.

Process Pond Remedial Investigation Report

The Process Pond Remedial Investigation Report will present all data and information obtained during the process pond remedial investigation. The report will describe the investigation and present study results using appropriate maps, graphs and tabulations. The report also will provide detailed discussion of all study elements. Relevant information from the ongoing Phase II WRM investigation, the Phase I WRM report and the ongoing plant water balance study will be integrated with information collected during the Process Pond RI and one comprehensive process pond RI report will be completed.

The Process Pond RI report will include an endangerment assessment for these ponds. As described in the EPA Conceptual Work Plan (CH2M Hill, February 16, 1986), primary exposure pathways from process ponds is through groundwater with ingestion of surface water being a somewhat more remote exposure pathway. The process pond endangerment assessment will, therefore, parallel the comprehensive endangerment assessment of groundwater and surface water pathways.

This comprehensive endangerment assessment will be a component of the ASARCO East Helena Comprehensive RI report (see Comprehensive Remedial Investigation Study Plan, Hydrometrics, May 1987). Since process pond RI activities are to be expedited ahead of most of the comprehensive RI activities, the process pond endangerment assessment may be somewhat abbreviated.

Preliminary Remedial Action Alternative Assessment

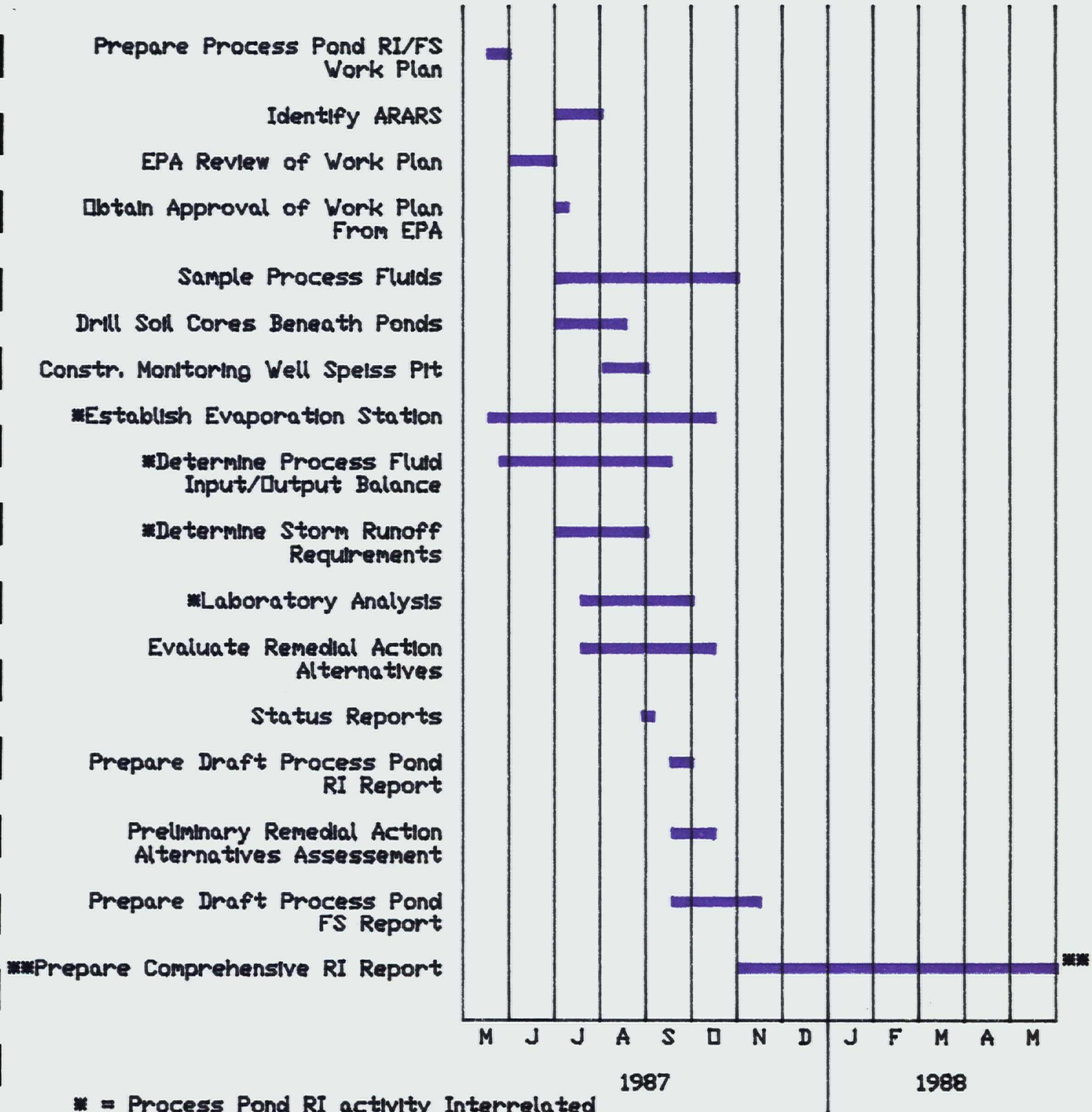
This report will contain a list of preliminary remedial action alternatives. This list will provide a preliminary review of the course of the process ponds feasibility study prior to development of the feasibility study report.

Process Pond Feasibility Study Report

The Process Pond FS report will list all remedial action alternatives and discuss the relative merits of various alternatives. The report will include a description of the screening process of each alternative and present remedial action recommendations.

PROCESS POND RI/FS WORK PLAN TIME SCHEDULE

Many elements of this work plan are interrelated with other investigation activities at the ASARCO plant site and are, therefore, already in progress. Many study activities scheduled as part of the ongoing Phase II WRM investigation and the plant water balance study have been completed and some activities will continue somewhat independently of this work plan. Figure 2 shows the time schedules of the Process Pond RI/FS work plan and also shows related activities conducted as part of the other ongoing investigations. The process pond RI/FS investigation will begin as soon as authorized by ASARCO, Inc. It is anticipated that project field work pertaining exclusively to the process pond RI/FS will begin July 1987. The Process Pond RI is scheduled for completion three and one-half months after the project is initiated. The process pond FS is scheduled to be complete approximately six weeks after completion of the RI.



* = Process Pond RI activity interrelated with the on going PHASE II WRM or Plant Water Balance Investigations.

** = Comprehensive RI report schedule is described in the comprehensive RI Study Plan, Dated May, 1987

FIGURE 2.
PROCESS POND RI/FS TIME SCHEDULE

REFERENCES

CH2M Hill, 1987. Draft Conceptual Work Plan RI/FS, East Helena Site (ASARCO), Helena, Montana. 68-8L30.0/W64481 wp, February 16.

Hydrometrics, 1984a. Hydrogeological Investigation of ASARCO East Helena Plant - Water Resources Plan.

_____, 1984b. Quality Assurance Program Plan - ASARCO East Helena Plant Water Resources Investigation. September.

_____, 1986a. Report on Water Resources Monitoring - ASARCO East Helena Plant - Draft.

_____, 1986b. Water Resources Investigation - ASARCO East Helena Plant, Phase II Remedial Investigation Work Plan.

_____, 1987. Comprehensive Remedial Investigation Study Plan, ASARCO, East Helena, Montana. May.

APPENDIX 1.

QUALITY ASSURANCE PROGRAM PLAN ADDENDUM

0130469

HYDROMETRICS HELENA, MT

FIELD OPERATING PROCEDURE

DETERMINATION OF SETTLEABLE MATTER
HFOP-209F-87

Marilyn Null
Send her

1. GENERAL DISCUSSION

Settleable matter in surface and saline waters as well as domestic and industrial wastes may be determined and reported on a volume (milliliters per liter) basis.

2. APPARATUS

The volumetric test requires an Imhoff cone.

3. PROCEDURE

By Volume:

Fill an Imhoff cone to the 1L mark with a thoroughly mixed sample. Settle for 45 minutes, gently stir sides of cone with a rod or by spinning, settle 15 minutes longer, and record volume of settleable matter in the cone as milliliters per liter. If the settled matter contains pockets of liquid between large settled particles, estimate volume of these and subtract from volume of settled matter. The practical lower limit of measurement is about 1 mL/L. Where a separation of settleable and floating materials occurs, do not estimate the floating material as settleable matter.

4. CALCULATION

mg settleable matter/L = mg suspended matter/L
- mg non-settleable matter/L

REFERENCES:

Standard Methods for the Examination of Water and Wastewater, P. 96, 290F, American Public Health Association, Washington, D. C. 1980.

HYDROMETRICS HELENA, MT

FIELD OPERATING PROCEDURES

OPERATION OF A "CLASS A" EVAPORATION STATION (HFOP-55-5/87)

The following instructions describe the operation and maintenance of a U.S. Class A evaporation station. Also attached is a data form for recording measurements.

EQUIPMENT

a) A 48-inch aluminum Class A evaporation pan.
b) A micrometer hook gage and stilling well.
c) An anemometer for determining daily wind movement over the pan.
d) An 8-inch precipitation gage and windshield.
e) A water temperature thermometer.
f) A water-storage tank to provide a reserve supply of water for the pan.

PROCEDURE

A) Place the hook gage on the stilling well and adjust the hook in the well until the point is below the surface of the water. Slowly turn the adjusting nut clockwise until the point just pierces the water surface. Reflection of the sky in the water will assist in determining when the point first breaks through the surface. Remove the gage from the well and read the scales.

The figures on the stem represent whole inches and the intermediate graduations represent tents of an inch. The figures on the circular scale represent hundredths of an inch and the intermediate graduations represent thousands. Whenever an observation is taken, the scale on the stem is read to tenths of an inch, as indicated by the first graduation at or above the top of the knurled adjusting nut. The circular scale on the adjusting nut is read to the nearest hundredths of an inch at the index. Both scale readings are added and the sum represents the gage reading.

Example: A scale reading of 25 on the stem indicates 2.5 inches; a scale reading of 31 on the circular scale indicates a value of 0.035 inches. The gage reading is, therefore, 2.5 + 0.035, or 2.535 inches.

Enter the readings obtained as above in the appropriate spaces on the attached form.

B) If needed, fill the pan to a level 2 inches below the rim and refill when the water has receded 1 inch, i.e. to the 3-inch line. When heavy rains threaten to overflow the pan or raise the water beyond the range of the hook gage, remove enough water to lower its level to within the 2- to 3-inch range.

C) Read the anemometer counter in tenths of miles and record the measurement.

D) Read the precipitation gage. If gage is non-recording, remove the ruled measuring stick and insert it into the top of the gage slowly until touching the bottom. Remove the stick and read the area wetted by the water in the gage. Record this reading on the form. Always record some value, whether 0 or greater. Following recording the precipitation measurement, remove the gage funnel and empty the inner tube containing the water. This should be done every time a measurement is taken to remove any debris. If the gage contains snow or ice, take the sample to a heated enclosure and melt the sample. Pour the water into the gage and remeasure the precipitation.

E) Read and record the maximum and minimum water temperature. A submersible thermometer is used for this measurement. The thermometer is mounted horizontally on a plastic holder which rests on the bottom of the pan. A non-magnetic metal handle is fastened to the bulb end of the holder and hooks over the edge of the pan. The holder should be located on the inside-bottom of the south side of the pan to insure that the thermometer bulb is shaded as much as possible from the direct rays of the sun. Submerge the thermometer gently to keep the small indicators inside the thermometer tube from being jarred from the mercury column. Read the temperature to the nearest whole degree as indicated by the end of the metal index nearest the column of mercury in each tube. If possible, the thermometer should be read submerged, before removal from the pan. Enter the highest and lowest readings in the proper water temperature columns of the record form. To reset the thermometer, place the magnet directly above one of the metal indices. Move the magnet slowly toward the mercury column until the index touches the mercury. Gently lift the magnet away from the tube to prevent the index from springing away from its contact with the mercury. Repeat this procedure with the other index.

MAINTENANCE

Inspect the pan for leaks carefully once a month, since any leaks will render the measurements valueless. Report the finding of any leaks on the observation form. Since the heat characteristics of all evaporated pans must be identical, they must not be painted. Clean the pan as frequently as necessary to keep it free from sediment, scum, and oil films. An oil film will materially reduce the rate of evaporation. The pan must be emptied only by siphoning and/or dipping the water out. Under no circumstance is the pan to be lifted and emptied with any significant amount of liquid remaining in the pan.

During months when freezing conditions are likely, empty, clean and store the pan. If it is left a measuring site, turn pan bottom-side up and secure to the platform.

The growth of algae in the evaporation pan can be discouraged by the addition of small amounts of copper sulfate to the water. However, algae already present must be removed by a thorough cleaning of the pan.

The cylindrical well provides an undisturbed water surface around the hook gage and, in addition, provides a support for the gage. The well base is provided with leveling screws and lock nuts in each corner. Place the stilling well in the pan about one foot from the north edge. Level the top rim of the well using the three leveling screws. Clean the stilling well occasionally and remove any sediment. When cleaning or making any adjustments, record hook-gage readings before and after such actions.

Keep the thermometer assembly free from dust and sediment. Use a soft wet cloth for cleaning the unit. A very fine grade steel wool or SOS pad can be used to clean salt deposits from the thermometer bulb and tube.

If the mercury column of the maximum/minimum thermometer becomes separated, the resulting temperature readings will be erroneously recorded. When this condition is noted, action should be taken immediately to rejoin the column. Remove the thermometer and holder from the pan, but do not remove the thermometer from holder. Hold the thermometer near its bulb end and swing it rapidly in an arc until the mercury column is rejoined, taking care not to strike any object.

EVAPORATION/PRECIPITATION DATA FORM

Location ____________________ Month/year ____________________

Tech. Name	Date/ Time	Max Temp	Min Temp	Gross Wind Run	Daily Hook Gage Reading	Hook Gage Reading After Water Added	Amount of Water Added (in)	Precipitation (inches)

0130473